

KELLEY DRYE & WARREN LLP

A LIMITED LIABILITY PARTNERSHIP

WASHINGTON HARBOUR, SUITE 400

3050 K STREET, NW

WASHINGTON, D.C. 20007-5108

(202) 342-8400

FACSIMILE

(202) 342-8451

www.kelleydrye.com

CHIP YORKGITIS

DIRECT LINE: 202-342-8540

EMAIL: cyorkgitis@kelleydrye.com

NEW YORK, NY

LOS ANGELES, CA

CHICAGO, IL

STAMFORD, CT

PARSIPPANY, NJ

BRUSSELS, BELGIUM

AFFILIATE OFFICE

MUMBAI, INDIA

July 29, 2016

Marlene H. Dortch  
Secretary  
Federal Communications Commission  
445 12th Street S.W.  
Washington, DC 20554

Re: Notice of Ex Parte Presentation Regarding the Modification Applications of Ligado Networks, LLC: IB Docket Nos. 11-109 and 12-340; IBFS File Nos. SES-MOD-20151231-00981, SAT-MOD-20151231-00090, and SAT-MOD-20151231-00091

Dear Ms. Dortch:

On Wednesday, July 27, 2016, representatives of the aviation and aerospace communities met with staff from the Wireless Telecommunications Bureau, the Office of Engineering and Technology, the International Bureau, and the Office of General Counsel of the Federal Communications Commission (the "Commission") to discuss the above-referenced modification applications of Ligado Networks, LLC. A list of the meeting participants is appended hereto as Attachment A. Many participants are members of the Joint Aviation Parties and the Joint Aviation Reply Commenters, or are members of the Aerospace Industries Association ("AIA"), all of which filed comments or reply comments in the above-referenced dockets and file numbers in response to the Commission's April 22, 2016, Public Notice setting forth their positions. (Several of the participants also filed individual comments or reply comments.)

In their comments and reply comments in which they submitted or participated, the attendees at the meeting had articulated the theme that the serious issues of harmful interference to GPS and satellite communications ("SATCOM") posed by the proposed Ligado operations must be addressed and resolved, and corresponding license conditions formulated, prior to any Commission action on the Ligado modification applications.<sup>1</sup> The Commission should not move forward, as Ligado would have it do, simply on the basis of Ligado acknowledging that there are

---

<sup>1</sup> The comments and reply comments of Iridium Communications Inc. ("Iridium") addressed only SATCOM issues.

Ms. Marlene H. Dortch

July 29, 2016

Page Two

issues to be addressed and making a commitment to enter into or continue discussions with interested parties. The aviation and aerospace attendees reiterated these concerns throughout the meeting. Regarding certified aviation GPS receivers, further analysis and testing are required, followed by rigorous license conditions protecting all receivers operating under existing and future Minimum Operational Performance Standards ("MOPS") with the active upfront and ongoing involvement of the Federal Aviation Administration's ("FAA") and the Commission, with responsibilities for modification, interpretation, and expeditious and effective enforcement clearly defined. Concerning non-certified receivers, which play an important and increasing role in aviation operations, the Ligado testing is inadequate, using a subjective interference criterion that does not account for velocity or timing performance of GPS receivers, and is not recognized by the domestic and international manufacturing and user community. The Department of Transportation's testing of the potential for interference to non-certified GPS receivers using the well-established and broadly accepted 1 dB C/N<sub>0</sub> degradation metric is nearing its completion, and the Commission should wait for those results and the opportunity for interested parties to fully review and comment on them before acting. Finally, the potential for serious interference to aviation (and other) uses of satellite communications from the proposed Ligado operations has yet to be fully addressed in the public record, and could threaten important aviation operations in the air and while on the ground. Any basis for compatibility between Ligado's proposed operations and the Iridium and Inmarsat systems needs to be understood, analyzed, and tested and made part of the public record before a grant occurs. Attachment B, appended hereto, was made available to the Commission staff during the meeting summarizing the concerns of the aviation and aerospace industries with the modification applications and the issues that should be addressed before action is taken on those applications.

In the meeting, the aviation and aerospace representatives explained the many critical ways in which they utilize the Global Positioning System ("GPS") to support air safety and operational efficiency. Representatives of Airlines for America and its airline members began with a brief slide presentation appended hereto as Attachment C, and explained that aviation relies on GPS for performance-based navigation ("PBN") to secure aviation safety and improve many aspects of aviation operations as aviation use of GPS continues to expand and evolve. For example, as of February 2016, more than 2700 airports depended upon GPS to support precision approaches, and GPS has become an integral capability for flexible and improved aircraft enroute navigation. The aviation representatives discussed the FAA's Next Generation of air traffic control ("NextGen"), by which the United States is transitioning to a national airspace system dependent on the GPS system and the increased functionality it provides to aircraft and air traffic controllers. The deployment of NextGen, which has been underway for almost a decade and will continue for another 10-15 years, will introduce a variety of improved and even more GPS-dependent technologies, systems, and operational measures that rely on precise GPS data. The FAA has mandated that as of January 1, 2020, GPS-based Automatic Dependent Surveillance – Broadcast ("ADS-B") must be implemented, and that ADS-B will be expanded in the years following to autonomous navigation, heightening the criticality of accurate GPS-

Ms. Marlene H. Dortch  
July 29, 2016  
Page Three

supported readings of position, timing, and velocity. Numerous other attendees underscored how major aviation safety risks are mitigated by GPS-based systems. Examples were discussed of how interference to GPS-dependent systems could result in multiple missed approaches and create a cascading effect in the national airspace with increased risks to air safety and operational efficiency. The aerospace representatives also explained several ways in which GPS is leveraged to develop new capabilities – such as synthetic air speed and vision systems – and that modern aircraft often have many different critical systems on board which have their own individual non-certified GPS receivers. Moreover, both private and business owners in the aviation and aerospace communities also depend on non-certified GPS devices in their operations for aviation ground systems and IT networks.

The representative from the Helicopter Association International spoke about the importance of GPS, through systems such as those enabling terrain awareness, for example, in providing accurate and reliable navigation. There are approximately 10,000 helicopters registered for use in the United States today, including an estimated 900 air ambulances. He explained that many helicopters depend on GPS due to their operation at low altitudes, typically below 5,000 feet, and very commonly below 500 feet. Such flight profiles provide a greater exposure to obstructions and often hinder receipt of other ground-based navigational aids, and therefore GPS is often the only external navigational data available. He also emphasized that helicopters often land or take off from unprepared sites including roads, parking lots, and fields. Accurate and trustworthy GPS is absolutely critical in those situations, especially in emergencies where pre-planning of sites is not possible.

The member from the International Air Transport Association explained that last year there were more than 1.6 million commercial flights to and from the United States. This underscores the global nature of the potential interference threat presented by Ligado's proposed terrestrial operations. Those operations not only pose a danger for GPS operation, but also other global navigation satellite systems ("GNSS"), such as Galileo and GLONASS, which are expected to be used increasingly by aircraft operating in U.S. airspace (once the receiver standards for safety of life airborne operations with these constellations are put in place and applicable Technical Services Order ("TSO") authorizations are issued by the FAA), and must be accommodated to ensure broad aviation safety.

The representatives of AIA pointed out that unmanned air systems ("UAS") represent an emerging technology that will depend on GPS to allow operators to have awareness of where they are, for fail-safe controls, and for other actors to know where they are. These requirements depend on reliable GPS as UAS become more and more prevalent in the coming years.

In response to Commission questions, the representative from Rockwell Collins explained that potential backups existed when interference to certified GPS receivers occurs, but they were suitable only for very brief interruptions of signal and not meant to address extended

Ms. Marlene H. Dortch  
July 29, 2016  
Page Four

interference threats. In short, for aircraft dependent on GPS, there is nothing available to replace or augment long-term dependence on access to accurate GPS-derived position, timing, and velocity information.

The Rockwell Collins representative also explained, in response to a question whether GPS receiver emissions masks were becoming more stringent and with reference to the RTCA, Inc. ("RTCA") standards development process, that while emission masks may become sharper over time (e.g., the GLONASS mask was given as an example), the life cycle for aviation radio equipment pursuant to a given standard was at least twenty (20) years, with some airframes operating as long as thirty (30) years. The ASRI representative added that, regardless of mask capabilities, the important objective was a demonstrated lack of harmful interference to GPS when used to support aviation operations, whether intentional or accidental.

Staff also inquired about the aviation and aerospace representatives' view of Ligado's proposed "operational deference" approach to protecting certified aviation receivers from harmful interference whereby Ligado would operate within emissions restrictions approved by the FAA, which would also determine how much interference was acceptable. None of the industry representatives endorsed the approach as proposed by Ligado at this time, citing the lack of agreed testing and detail in the current record. Several members opined that many problems with the proposal remain, and recommended the FAA take an active role in an RTCA-led assessment process to fully understand the effect of all Ligado emissions on certified aviation GPS receivers before any grant by the Commission is made on Ligado's application. Such a public process would fully assess all implications and interference examples, setting out the emissions limits and parameters required to protect certified receivers. As emphasized by the ASRI representatives, echoing the comments and reply comments of the Joint Aviation Parties and the Joint Aviation Reply Commenters, any theoretical establishment of operational limits should be backed up by rigorous real-world testing, and any roll out should occur in phases to ensure any unexpected interference is controlled in a safe and manageable process. The aviation representatives urged the Commission to set milestones and clear conditions based on which of the roll-out or operations can be promptly suspended if harmful interference occurs.

The aviation and aerospace representatives also urged the Commission to engage the FAA to develop appropriate and complementary roles for the agencies in setting conditions on Ligado operations to protect certified GPS receivers once a Ligado network is operational. An agreed joint Commission-FAA process to deal with reports of GPS interference and enforce the license conditions ultimately adopted, would appropriately allow for immediate protection of aircraft safety, and also support a quicker resolution of the harmful interference. The interference resolution procedures to be applied should include a full site assessment before Ligado is able to reinstate operations after harmful interference occurs, and use the conclusions of such assessment to assess and potentially modify any Ligado license conditions over time as proves necessary and advisable.

Ms. Marlene H. Dortch  
July 29, 2016  
Page Five

The aviation and aerospace representatives also underscored the need for more study into the potential interference from terrestrial handsets operating in the Ligado bands. Further information is required to understand adequately how those devices could potentially interfere with GPS signals. The representatives noted that the FAA's 2011 report had stated the issue was still to be appropriately studied. This still has not occurred. Therefore, the aviation and aerospace representatives would anticipate the Ligado studies be sent to RTCA as part of an appropriately complete assessment of handset interference issues before any conclusions be made.

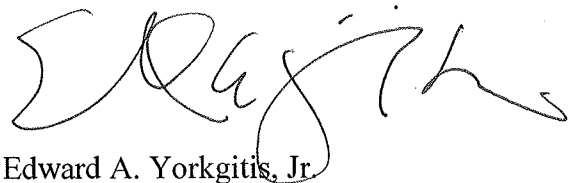
In terms of SATCOM, the aviation and aerospace representatives asserted that assessments should be conducted on the effects to the Iridium and Inmarsat systems before proceeding with any decision on the Ligado applications as it is a major safety, operational, and financial concern for aviation end users. The Iridium representatives noted that they are currently engaged in discussions with Ligado and the FAA to address these concerns. Aviation representatives made clear that protection from harmful interference to Iridium and Inmarsat was critical for airlines not only during flight operations but during ground tests prior to takeoff, when many terrestrial handsets might be operating in the Ligado band and pose an interference threat.

The representatives welcomed any further questions the Commission might have and stated that they stood ready to provide any assistance as the Commission considers the proper action in response to the Ligado applications and the record developing in response to them.

This *ex parte* notice and its attachments are being filed with the Office of the Secretary of the Commission as require by Section 1.1206 of the Commission's rules.

Please direct any questions to the undersigned.

Respectfully submitted,

A handwritten signature in black ink, appearing to read 'E. Yorkgitis, Jr.', with a stylized flourish at the end.

Edward A. Yorkgitis, Jr.

*Counsel for Aviation Spectrum  
Resources, Inc.*

Ms. Marlene H. Dortch

July 29, 2016

Page Six

CC via email:

Charles Mathias, Wireless Telecommunications Bureau

Ronald Repasi, Office of Engineering and Technology

Paul Murray, Office of Engineering and Technology

Michael Ha, Office of Engineering and Technology

Jose Albuquerque, International Bureau

Karl Kensinger, International Bureau

Robert Nelson, International Bureau

Jennifer Tatel, Office of General Counsel

KELLEY DRYE & WARREN LLP

Ms. Marlene H. Dortch  
July 29, 2016  
Page Seven

Attachment A

Attendees at ex parte meeting on July 27, 2016  
(in person unless noted otherwise)

Aviation and Aerospace Representatives:

- Cortney Robinson, Aerospace Industries Association
- Miles Lifson, Aerospace Industries Association
- David Berg, Airlines for America
- Robert Ireland, Airlines for America
- Paul McGraw, Airlines for America (by telephone)
- Christopher Julius, American Airlines
- Mike Hirschberg, American Helicopter Society (AHS) International
- Andrew Roy, Aviation Spectrum Resources, Inc. ("ASRI")
- Greg Baker, Aviation Spectrum Resources, Inc. ("ASRI")
- Edward A. Yorkgitis, Jr., Kelley Drye & Warren LLP, counsel for ASRI
- Lauren Myers, Kelley Drye & Warren LLP (Summer Associate)
- Tim Murphy, Boeing (by telephone)
- James Dickens, Bristow (by telephone)
- Laura Delgado Lopez, Harris Corporation
- Chris Martino, Helicopter Association International
- Mike Franceschini, Honeywell (by telephone)
- Chad Heflin, International Air Transport Association
- Maureen McLaughlin, Iridium
- Don Jansky, Jansky-Barmat Telecommunications, representing Iridium (by telephone)
- Brian Weimer, Sheppard Mullin Richter & Hampton LLP, counsel for Iridium
- Scott Kotler, Lockheed Martin
- Megan Eisenstein, National Air Transportation Association
- Sai Kalyanaraman, Rockwell Collins, Inc.
- Sasha Johnson, United Airlines
- Charles R. Stewart, United Airlines
- Timothy Totten, United Parcel Service

Federal Communications Commission Representatives:

- Charles Mathias, Wireless Telecommunications Bureau
- Ronald Repasi, Office of Engineering and Technology
- Paul Murray, Office of Engineering and Technology
- Michael Ha, Office of Engineering and Technology
- Jose Albuquerque, International Bureau
- Karl Kensinger, International Bureau
- Robert Nelson, International Bureau
- Jennifer Tatel, Office of General Counsel

## **SUMMARY OF AVIATION AND AEROSPACE CONCERNS WITH LIGADO LICENSE MODIFICATION PROPOSAL**

IB Docket No. 12-340; IB Docket No 11-109;  
IBFS File Nos. SES-MOD-20151231-00981; SAT-MOD-20151231-00090;  
SAT-MOD-20151231- 00091

July 27, 2016

### **AVIATION DEPENDENCE ON GPS FOR SAFETY AND EFFICIENCY**

- Adequate protections against interference to GPS is essential to modern aviation systems that depend on uncompromised GPS products in all phases of flight for human safety and operational efficiency.
- Aviation and aerospace technologies and capabilities continue to innovate and improve functionality in reliance upon receipt of GPS signals that would be impacted by increased potential for interference.
- The aviation community has implemented the GPS Wide Area Augmentation System (WAAS) capability in its receivers to provide the high accuracy required for flight navigation, especially vertical position accuracy.
- Both WAAS, and the Local Area Augmentation System (LAAS), are replacing older ground-based navigational aids as the primary source for data for precision flight operations in and around airports.
  - WAAS reference receivers are a class of high precision receivers and perform safety-critical functions to support air navigation. Any degradation in performance directly impacts safety of operations.
- GPS is the key sensor for the Automatic Dependent Surveillance – Broadcast (ADS-B) system, which is a lynchpin capability to enable the FAA's Next Generation airspace management system.
- The fast-growing number of unmanned aircraft systems (UAS) of all sizes rely on GPS navigation performance to an even greater degree than do manned aircraft – as UAS typically have no alternate means of navigation and there is no human onboard to manually react to any GPS position anomalies.
- With respect to both manned and unmanned aircraft operations, there are an increasing number of sensor applications, including those employed to survey critical infrastructure or respond to disasters, which are also dependent on GPS to orient their systems.
- An aircraft unable to receive GPS signals reliably will not meet the Required Navigation Performance (RNP) mandated by the FAA needed for congested or precision airspace operation.
- Aviation ground equipment, IT and support systems, and some avionics, notably Embedded GPS Inertial (EGI) Navigation systems, all heavily utilize non-certified GPS receivers for position, velocity, and/or timing information.
- Digital Map and Terrain Warning and Avoidance systems rely on accurate horizontal and vertical position information provided by GPS and EGI systems.



## **AVIATION AND AEROSPACE RECOMMENDATIONS FOR GPS TESTING OF CERTIFIED GPS RECEIVERS THAT FORMS BASIS FOR FAA-APPROVED OPERATING CONDITIONS BEFORE ACTION IS TAKEN ON THE LIGADO APPLICATIONS**

- The planned Ligado deployment creates serious concerns about potential interference to aviation operations and their ability to rely on GPS which must be addressed and resolved before the FCC can approve any aspects of the Ligado applications.
  - Aviation and aerospace industries appreciate the need for additional spectrum for commercial mobile broadband and the challenges to the FCC to identify viable spectrum.
  - Any potential for interference to aviation's use of GPS threatens public safety and the efficiency of airline operations on which our citizens and businesses depend.
    - Aviation and aerospace industries appreciate that Ligado is in discussion with the FAA and numerous other parties in various industries regarding interference threats to GPS, but that is not sufficient for grant of the applications.
    - The aviation and aerospace communities do not make safety decisions based on good intent and discussions; the required burden of proof is extremely high to maintain the safety of the flying public.
- Study and testing of the impact from the proposed operations on certified aviation GPS receivers used by fixed wing aircraft and helicopters under the auspices of the FAA and RTCA should precede any FCC action on the Ligado applications.
  - A comprehensive theoretical study of Ligado's full emission and deployment plan should be conducted under the authority of the FAA, fully utilizing the expertise available in the RTCA.
  - RTCA involvement would ensure a fully transparent process designed to include relevant aviation experts and Ligado.
  - Ligado's proposed contribution to the interference environment needs to be considered in conjunction with other sources of existing interference, not independently – given the safety aspects of a reliable GPS signal.
  - The theoretical assessment should be backed-up with a physical testing program of aviation GPS compatibility under the oversight of the FAA, with appropriate involvement by the FCC, to verify results.
- Based on the theoretical and field test results, Ligado should develop operational limits and conditions in consultation with aviation and with final approval coming from the FAA, which should retain ongoing oversight over compatibility issues.
  - Any aviation safety conditions imposed on Ligado must apply to all Ligado emissions.
  - All FAA TSO avionics in use and being developed should be covered.

## **ANY LIGADO TERRESTRIAL ROLL-OUT SHOULD BE IN STAGES COORDINATED WITH THE FAA AND THE AVIATION INDUSTRY**

- Assuming FAA-approved Ligado operating conditions are successfully established based on testing and analysis, any Ligado deployment should be fully coordinated with FAA and the aviation industry.

- The rollout should be planned in a gradual manner, with set milestones and clear conditions under which to suspend the roll-out if interference occurs.
- A joint FCC/FAA process must be in place before Ligado operations begin.
  - The process must provide for steps to ensure immediate cessation of Ligado operations when interference to aviation use of GPS is experienced, and subsequent full site assessments must take place before reinitiating Ligado operations.
  - Testing cannot mitigate potential fault conditions in Ligado equipment.

**THE 1 DB DEGRADATION IN C/N<sub>0</sub> METRIC BEING ASSESSED BY THE DOT IS THE ONLY DEFINITIVE METHOD FOR ASSESSING NON-CERTIFIED GPS INTERFERENCE TOLERANCES**

- Unlike Ligado position error-focused testing, the 1 dB focuses on all elements of GPS receiver performance, including timing and velocity.
- The 1 dB methodology conforms to existing international standards, is supported by all three manufacturers that have settled with Ligado, and accounts for aggregate interference (in and out of band).
- Ligado's GPS-specific KPI position error testing does not consider other GNSS systems that will emit in the U.S.

**AVIATION USERS HAVE CONCERNS WITH POTENTIAL INTERFERENCE TO SATCOM**

- AMS(R)S SATCOM is used by almost all long range aircraft for enhanced connectivity and data services in remote areas.
- Inmarsat and Iridium SATCOM terminals are part of the FAA's Minimum Equipment List (MEL) for aircraft to operate in optimized oceanic routes.
- Aircraft SATCOM is used 'gate-to-gate,' operating extensively while on the ground for pre-flight connectivity checks, and enhanced data connectivity services.
- Inmarsat's agreement with Ligado has not been made public in order for users to fully understand the effect on Inmarsat's customer terminals and potential impact on safety and efficiency of operations, as well as potential equipment change-out costs.
- No assessment has yet been conducted on the effects to the Iridium system, and this must be determined before proceeding with any decision.
- The lack of public information on the impact of potential interference from Ligado under either SATCOM system is a major safety and operational concern for end users.



# Criticality of GPS to Fixed Wing Commercial Aviation

ASRI – A4A and “Joint Aviation Parties”

July 27, 2016

# Reliance on GPS for Performance Based Navigation (PBN) benefits

- PBN approaches enable enhanced accuracy, safety, noise abatement, fuel conservation, and increase capacity.
- FAA has expanded Area Navigation (RNAV) approaches over time, now twice as prevalent as ILS radio guided approaches.
- PBN approaches require GPS for position accuracy.
- 2,747 airports depend on GPS-enhanced position for precision approaches as of February 2016.
- Compromise of GPS signal, especially on approach, causes flight disruptions, including missed approach and diversion to another airport – and can have safety implications.

# NextGen Summary

- The US is transforming from radar navigation and surveillance to a GPS dependent system.
- Next Generation of ATC known generally as “NextGen”.
- Goal is increased safety and greater efficiency. Public benefits are greater system capacity, reduced delays, enhanced safety and reduced emissions.
- NextGen employs a variety of technologies, systems and operational measures that rely on precise GPS data.
- FAA estimates NextGen will cost taxpayers and the private sector approximately \$40 Billion – a huge investment by all stakeholders.

# US Requirements For Industry

- “2020 Mandate”: essential first part of NextGen
  - FAA is directed by Congress.
  - Federal Aviation Regulations (FARs) require GPS-based Automatic Dependent Surveillance – Broadcast (ADS-B Out) for operations from **January 1, 2020**.
  - Precise GPS position reporting is also specified by FAR.
  - Eventual future expansion of ADS-B to autonomous navigation: the criticality of reliable GPS will only be greater over time.
  - Unpredictable interference from ground systems would be a safety of flight issue.

# GPS Based Navigation Enhances Flight Safety

- Three major aviation safety risks are mitigated through the use of GPS
  - Approach and Landing accidents
    - During the 1990s as many as 9 approach and landing accidents (4 of which were fatal).
    - Since 1999 there have only been 2 U.S. carriers with such accidents in the U.S. with one of those aircraft not equipped with GPS\*.
    - As General Aviation (GA) has made GPS “Glass Cockpits” standardized in new aircraft, fatal approaches and landings at night have been reduced by 30%\*.
  - Controlled Flight into Terrain (CFIT)
    - Most lethal of all accidents
    - On Board Terrain alerts were unstable prior to GPS.
    - Enhance Ground Proximity Warning Systems (EGPWS) combine GPS and other technologies to provide look-ahead terrain information to the flight crew.
    - GA usage of GPS has provided a 44% reduction in CFIT over the past 5 years\*.
  - Runway Incursions
    - Volpe National Transportation Systems Center concluded a mix of airport surface moving maps (which depends on GPS) could prevent 1/3 of all runway incursions.